"'Oh! I slipped the surly bonds of Earth[1]' . . . and ran into space weather!"

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Over the past decade the concept of "space weather" has been introduced and matured in both the scientific community and popular press. Likewise the concept of "space climatology" recently also is being advanced. Closely linked to these concepts are their impacts on ground- and space-based technological systems; one such system commonly mentioned is manned space flight exemplified by the Space Shuttle and International Space Station (ISS). From a manned space flight perspective, space weather and space climatology have significant effects on the amount of radiation exposure received by humans in space from the ambient high-energy charged particles present in interplanetary space and trapped in the geomagnetosphere. Whereas the impact of space weather for most technological systems is usually discrete and well correlated in time, the principle impact of space weather and space climatology is to increase the probability of latent cancer formation in the astronaut/space traveler cohort. In this regard, while space weather may be the dominating factor for a given mission, over the life of a long-term program such as the Space Shuttle or ISS space climatology is the controlling factor of latent cancer risk. Human radiation exposure enhancements associated with space weather disturbances has been a concern among scientist and mission controllers since the inception of manned spaceflight nearly forty years ago. This led NASA to develop, in conjunction with the Environmental Science Services Administration's Space Disturbance Forecast Center and the USAF/AWS, the Solar Particle Alert Network (SPAN)—the foundation of an initial U.S. space weather monitoring and forecasting service. Since Apollo, routine space flight operations have evolved to include the use of space weather and climatology data provided through a world-wide network of operational space weather data services to predict and recommend actions to minimize astronaut radiation exposures. NASA Space Radiation Analysis Group (SRAG) flight controllers use real-time space weather data to detect and assess the impact of solar particle events, outer electron belt enhancements, the formation of pseudo-stable additional trapped radiation belts, and the solar cycle modulation of trapped radiation belts and galactic cosmic rays. Energetic particle data from GOES spacecraft are automatically ingested from NOAA Space Environment Center data servers and used to drive a model for the estimating the exposure to astronauts from solar particle events. While adequate for current manned space flight support, the existing operational space weather support system requires improvements to address the anticipated evolution in both the character of manned missions as well as space flight operations management. Necessary space weather data improvements include: reliably available (near) real-time space weather data on a fixed schedule via redundant access methods that support autonomous data acquisition by computer systems behind enterprise firewalls; and rapid transition of promising research sensors into operational systems. Operational space weather models will also require improvements including: architecturally robust and evolutionarily stable models with well-defined interfaces for integration into existing operational systems; all inputs necessary to run these models are easily obtainable from space weather data providers; outputs include uncertainty and confidence intervals;

(preferably) platform independence and modular design for easy updating; and execution speeds on typical "high-end" PCs or workstations that keep pace with operational needs.

[1]Apologies to John Gillespie Magee, Jr.